Coal Re-mining in Ohio and the Post-Mining Land Use Implications of Re-mining Policy

Honors Research Thesis

Presented in Partial Fulfillment of the Requirements for Graduation *"with honors research distinction in Geography"* in the undergraduate colleges of The Ohio State University

by
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II. INTRODUCTION

On a fall day just two miles outside of New Lexington, the county seat of Perry County, OH, one can simultaneously witness the metamorphosis of a once beleaguered extractive landscape and the past and current trauma inflicted upon its ecosystems. Massive coal shovels and ore haulers operate with efficiency as they deposit overburden into refuse piles and remove remaining coal reserves from the sides of previously mined hillsides. Just to the north of this active site lie abandoned strip mines, discharging water heavily laden with dissolved acid, aluminum, iron and magnesium. Less than a mile to the south of the active sites, a reclaimed site is

Figure 1. A coal shovel removes overburden on Oxford Mining's New Lexington Operations

evidenced by the short grass covering the site, manmade ponds, and hay bales.

The term "remining" refers to the removal of viable coal reserves from abandoned mine sites that were mined prior to the passage of state and federal environmental legislation governing reclamation standards. This practice most frequently occurs on sites abandoned between 1940 and 1970, when surface mining became a transformative force on the southeastern Ohio landscape (Crowell, 1995). Ohio's abandoned surface and underground mines are a symptom of years of unrestrained degradation inflicted on the coal bearing regions of Appalachia. Prior to the enactment of the Ohio's B-Mine law in 1972, Ohio coal operators bore little to no responsibility for post-mining restoration (ODNR, 1980). Today, the remaining coal reserves in this scarred landscape are attractive to modern coal operations whose mining practices are sufficiently advanced to allow for coal extraction.

Identifying the presence of remining sites poses problems for researchers interested in studying their features because remining operations occurred for decades, escaping distinction in the conventional regulatory process. Geographers are uniquely suited to address this problem by enlisting spatial analysis techniques with remote sensing imagery to uncover the locations of remining sites and identify the characteristics of their changing land-use. The development of a GIS model for identifying remining sites would be of great use to ecologists, geographers, landscape historians, and engineers who research reclamation and land-use change.

Once modern reclamation standards were put in place, the vast majority of reclaimed sites (both remined and virgin), demonstrate land uses consistent with the terms “undeveloped”, “grassland”, “pastureland”, or “cropland” (DMRM, 1981). Though the planting of fast growing-grasses and shrubs satisfies the requirements of 1977’s Surface Mining Control and Reclamation Act and is believed to decrease costs for coal operators in the region, one is left to consider whether this constructed land-use is preferred by all actors in the remining process. In the case of remining sites, land-use preferences by public and private landholders are especially intriguing in light of the longstanding state of degradation under which these sites have been exposed (Skelly and Loy, 1974).

a. RESEARCH QUESTIONS

Today, remining is gaining significant regulatory and industry momentum even as virgin mining continuing its long-term decline in the region. Because of this developing shift, this work will pursue the answers to two questions. First, how can emerging geospatial technology allow users to identify remining sites on the landscape? Second, how do operators and landowners decide between various revegetation options, and how do these revegetation regimes influence the choice of constructed land use by public and private institutions and local communities?

While the Ohio Department of Natural Resources – Division of Mineral Resource Management’s record keeping for traditional permits is highly organized, comprehensive, and easy to search; the task of determining whether a site has endured pre-law mining previous to a modern-law mining operation is made difficult by the lack of explicit remining permits prior to the initiation of Ohio’s remining program. Because only thirty coal mining permits have been issued under the banner of "remining" in Ohio (over 300 remining permits have been issued in Pennsylvania), past remining operations must be uncovered using an alternative to the Ohio DMRM reporting mechanisms. GIS technology has been enlisted in this study to allow researchers to identify the areas that have been remined since the passage of the Surface Mining Control and Reclamation Act of 1977. While the sites selected as case studies were chosen (using non-probabilistic sampling) to represent the variety of landholder types and land-use prescriptions, the GIS method for identifying remined areas has been developed in this thesis as a tool to quantify site level change due to mining method as well as to provide a template through which future research will be able to isolate sites that have been strip mined before and after modern reclamation laws.

Proceeding from an understanding of the remining process and how to identify remining on the landscape, I examine re-mining's place within the framework of political ecology. Because remining is swiftly becoming a new transformative force on the southeastern Ohio landscape, political ecologists have a unique opportunity to study the simultaneous destruction and construction of environmental systems and landscapes (Robbins, 2004). Areas that have been mined and abandoned prior to the enactment of SMCRA infrequently demonstrate resiliency in the face of ongoing water quality and sedimentation concerns (Brady, 2002). Still, many pre-law sites pose real risks to local populations both of humans and wildlife from acid mine drainage, limited buffering capacities, ongoing sedimentation, and dangerous highwalls (USEPA, 2001). Because the degradation brought on by historic pre-law mining operations serve as symptoms of the prior negligence of both the state and industry, the process through which this landscape is re-engineered should be evaluated in order to discern the goals of local populations, the state, and corporate actors.

Armed with the knowledge that land-use change on reclaimed mine sites represents a reconstruction and reimagining of nature for human needs and purposes, the political ecologist will undoubtedly look on the remining process with a critical eye. In an investigation of a reforested site in Eastern Germany for example, Paul Robbins remarks that “this is no forest at all, but the dream of an engineer, a social construction of what a forest should look like, made by political planning on an extremely large scale (Robbins, 2004).” While any reclamation of a historic mine site will constitute a social construction of nature, the form that this reclamation takes affect must be evaluated on a case by case basis to assess both shifting vulnerabilities of local populations and changes in landscape utility for landowners (Robbins, 2004).

b. STRUCTURE OF THE THESIS

To understand the rise of remining through today’s regulatory environment, one must understand the history of surface mining and reclamation in the Ohio, the incentives that encourage it, and the institutional momentum it has gained through the coordinated efforts of industry and the state. Once the remining has been contextualized, this work puts forth a process by which remining sites can be identified on the ground using geographic information systems. Lastly, the study analyzes three remining site case studies through the theoretical framework of political ecology and argues that when landowners are asked to determine post-mining land-use, private and public landowners act in ways which maximize their landscape's utility to them.

III. BACKGROUND

The coal bearing region of Ohio has a troubling legacy with respect to historic extractive activity. Specifically, the extensive underground and surface mining since the late 1850's has left countless scars and continues to inflict ecological damage on watersheds through contact with acid forming materials and excessive sedimentation rates. The story of coal in Ohio begins in the 1752, when traders who mapped the region noted the presence of "coals" along the Hocking River, in what is modern day Athens County, Ohio (Crowell, 1995). The first production of coal was reported in 1800, when merely 100 tons of coal were mined in Jefferson County. By 1853, more than 1.2 million tons of coal were being mined in Ohio every year. (Crowell, 1995) As coal began to replace wood as the preferred fuel for many industrial purposes, coal production picked up steam. Furthermore, the development of Ohio railways in the middle of the 19th century provided the means of distribution, such that operators could now transport their coal to distant locations in need of fuel for development (Crowell, 1995). By 1918, the coal mining industry in Ohio employed just over 50,000 people, an all-time high (Crowell, 1995). Following World War II, surface mining began to unseat underground mining in the state as the principal method for coal extraction. This shift resulted in the loss of over 68% of total employment in the Ohio mining industry between 1948 and 1968.

Coal production peaked in Ohio in 1970, pulling over fifty five million tons of coal from the earth (Crowell, 1995). During this period (1950 – 1980) when surface mining became the dominant extraction technique, operators saw little logic in wasting their profits by reclaiming the lands they had disturbed.

In an attempt to address sedimentation and acidity concerns, however, The Ohio Department of Industrial Relations passed Ohio's first surface mine law in 1947 (ODNR, 1980). This law required the planting of trees and grasses on the unreclaimed spoil piles and deforested areas. By 1965, this law had been updated to include provisions requiring the burial of exposed coal seams, and the payment of $220 per acre of affected area to the Division of Reclamation (ODNR, 1980). By 1972, Ohio lawmakers recognized that these provisions were insufficient to mitigate the damage caused by exposed coal seams and sediment-choked streams. The general assembly passed Ohio's 'B'-Mine Law, which required the reclamation of surface-mined sites to approximate the land's original contour, along with the planting of grasses and legumes instead of trees to control sedimentation and slope erosion (ODNR, 1980). Ohio's 'B'-Mine Law was used as a template for the federal legislation known as the Surface Mining Control and Reclamation Act of 1977 (SMCRA). Indeed after the passage of SMCRA, The Ohio Strip Mine law of 1981 (C-Law), was granted primacy due to the fact that it exceeded the standards set in place by SMCRA (Crowell, 1995).

Ohio Strip Mine Laws have been modified over time, beginning with 'A'-Law Permits established in 1965 and continuing today in the form of Ohio's 'D'-Mine Law. Permits issued under 'A'-Law required only a regrading of spoil with little concerns for ongoing acid mine drainage and sedimentation. 'A' permits, and all mining that took place before their initiation, are commonly referred to as "pre-law mining". Modern law mining consists of B, C and D permits. These permits span 1972 to the present, and require the full return of the land to approximate original contour; the mitigation of acid mine drainage through the sealing of auger holes, covering of the coal seam, and restoration of the hydrologic regime; and the revegetation of surface lands for use as pasture, recreation, cropland, forest use, or undeveloped spaces.

Today, state and federal funds for abandoned mine land reclamation are raised through taxes on coal extraction in the region, but these funding sources are limited. Encouragingly, Ohio's Abandoned Mine Lands Program has recently seen its budget increase to nearly $20 million as a result of congressional action which changed the

Impacts of Unregulated Mining (Ohio)	
Miles of Streams Polluted by Acid Mine Drainage	1,300
Miles of Streams affected by Sediment Deposition	500
Acres of Land in Need of Major Reclamation Efforts	119,000

Table 1: Impacts of Unregulated Mining (ODNR, 1980)

way operator taxes on coal extraction are spread amongst the states. Unfortunately, the scale of Ohio's AML problem is so great as to ensure that this funding will never be sufficient to make sweeping improvements to the biological integrity of Ohio's watersheds and wetlands (Hunt, 2011). Even if one includes only abandoned mine sites in need of major reclamation effort (119,000 acres), at an average cost of $11,000 an acre the state would need over $ 1.3 billion to reclaim only the most degraded sites (Mauger, 2011). Furthermore, AML reclamation efforts rarely reclaim land to original contour, meaning the highwalls and pits which pose safety risks to local populations and recreationalists will remain in place, while only sedimentation controls, pollution abatement, and mine spoil regrading are implemented on-site.

Unofficial remining has occurred since the implementation of Ohio's 'B-Law', but was not often recorded as remining in permitting records. Ohio's official Remining Program began in 1995 with the issuance of a "modified effluent" permit to the Sands Hill Coal Company. Following suit, the USEPA proposed amendments in 2000 to the Clean Water Act to promote remining by loosening water quality standards on sites that had been mined previously (Strellec, 2000).

a. REMINING REGULATIONS AND INCENTIVES

Today, coal operators enjoy many permitting options when applying for remining permits. The Rahall Amendments to the Clean Water Act, passed in 1987 allowed operators to decrease the baseline standards for water quality on sites that had been degraded through pre-law mining (Stellec, 2000). This amendment provides a potential modification to the water quality requirements by monitoring 12 months prior to mining to determine what these new standards should be. These modified-effluent permits minimize the disincentives associated with being held responsible for previously degraded mine site conditions for which little to no remediation effort was required by law.

Furthermore, the Rahall Amendments allowed for the creation of non-numeric permits which base the release of bond on the fulfillment of certain best management practices rather than an adherence to water quality benchmarks for reclamation. These permits may be issued when the pre-monitoring of abandoned mine discharge is difficult to accomplish due to the infeasibility of baseline assessment. This could occur if the discharge is dispersed in the form of diffuse ground water flow, is unable to be accessed, or of too large a quanity. Non numeric permits require that an operator demonstrate an ecological lift to the area, but this is traditionally evaluated though water quality parameters and aquatic life indicators (USEPA, 2001).

The U.S. Army Corp of Engineers developed the Nationwide 49 permit, allowing operators to remine pre-law mine sites if they can demonstrate that the overall project, reclamation activity and new mining combined, will result in a net improvement of a sites biological indicators (USACOE, 2007). Additionally, ACOE mandates that operators wishing to mine under a Nationwide 49 permit cannot begin to remine a site if the area to be mined contains more than 40% virgin area. The majority (60%) of a NW 49 permit area must re-mine and reclaim previously mined lands. Currently, discussions on the appropriateness of this percentage requirement are being had by industry officials and some regulators. It is not uncommon for operators to make the case that “connecting two areas of abandoned mine land across space often requires the mining of virgin area in excess of the 40%

threshold (Mauger, 2011: 14).” The Nationwide 49 permit is set to expire in the first quarter of 2012. Policy directives have been drafted by Remining Task Force members in the hopes of altering this formula in time for the new permit guidelines.

There is hope in industry circles that remining could be further incentivized through the issuance of Rahall non-numeric permits if the scope of the term “ecological lift” could be expanded to include the elimination of dangerous highwalls, highwall pits, and spoil piles; the restoration of the site’s topography to approximate original contour, and the targeted reforestation efforts made to re-vegetate soil as opposed to the use of grass cover. In interviews with landowners and restorationists, I found increased openness to the idea of remining when proposed in concert with a reforestation effort.

Further incentives for remining have been developed including the AML Enhancement Rule in 2003, which allowed operators to use federal AML funding for remining reclamation; and the Energy Policy Act of 1992 which further removed regulatory burdens imposed due to unforeseen obstacles inherent in the mining of degraded abandoned mine lands (Mauger, 2011)(OSM, 2008). For example, if an operator accidentally uncovered an unknown underground mine shaft in the process of remining, and a release of acid mine drainage followed this event, the operator would be spared liability for this increase in pollution load. The Energy Policy Act of 1992 also reduced the revegation liability period from 5 to 2 years in Ohio (OSM, 2008).

IV. WHY INVESTIGATE REMINING?

Now is the moment to investigate this practice. Meeting quarterly, the leaders of Ohio's regulatory agencies and mining industries come together under the banner of the "Remining Task Force" to discuss ways to further streamline and incentivize the remining process at the state and federal level. Representatives from the Ohio EPA, US Army Corp of Engineers, Ohio Department of Natural Resources – Division of Mineral Resource Management, Office of Surface Mining, Oxford Mining Ltd., Rosebud Mining, and B & N Coal have been meeting since 2009, and have succeeded in marshaling support for efforts to simplify the permitting procedures for potential remining sites. More importantly however, this group has succeeded in guiding operators towards some of the most degraded sites in Ohio's watersheds by offering them a non-permitting option associated with Ohio's AML program. As of this writing, projects are near approval which could set the tone for the next twenty years or more of mining in the region by establishing what might more closely resemble a partnership between regulatory and permitting agencies.

Moreover, due to my experience working closely with operators and regulators examining this practice, I am uniquely suited to investigate the land use implications for areas that have been reclaimed through remining. While I have been trained as a student in the "Environment and Society" specialization within the Geography Department, I have also spent the last 3 years working as a GIS Research Assistant for the Department of Civil and Environmental Engineering and Geodetic Sciences. During my time there, I have gained a great deal of experience using GIS in combination with aerial photography and historic topographic mapping to identify abandoned highwalls, pits, and remining sites (Mauger, 2011). Many mining permits do not state explicitly whether or not a site has been remined, so using Geographic Information Systems to identify these sites by locating sites mined and abandoned prior to modern law allows for a more exact delineation of damaged area mitigated through remining. Along with the extensive experience I have acquired using GIS for mining applications, I have also had the opportunity to travel around the country to present at reclamation conferences and outreach events in an effort to raise awareness of this unique practice. Presenting my research has afforded me the opportunity to interview many industry officials and regulatory personnel on the details of remining policy and implementation. Their insights will be detailed further in the paper.

V. RESEARCH METHODS

a. GEOGRAPHIC INFORMATION SYSTEMS

Identifying remining sites on the ground can be challenging. For most sites, active virgin mining operations are indistinguishable from active remining operations, so historic imagery is one of the best tools geographers have to determine the extent of abandoned mine sites, and connect them with past and current remining operations. A step by step GIS model for identifying remining sites should prove useful for researchers studying land-use change in heavily extractive landscapes, civil engineers interested in selecting candidate sites for possible future remining operations, and political ecologists interested in examining forest fragmentation and land use change due to reclamation and mining.

1. Data Acquisition

As a student researcher for OSU's Department of Civil Engineering under the supervision of Tarunjit Butalia, Ph.D. and William Wolfe, Ph.D., I used geographic information systems to survey the entire Ohio coal bearing region for abandoned surface mine sites. High-resolution aerial photography provided as a base-map through ESRI (2009 NAIP Imagery) has been reviewed and digitized to identify 203,227 acres of unreclaimed coal highwalls and pits.

The software I used to perform this analysis is ArcGIS, a set of applications that allows users to organize layers of data spatially for the purposes of data modeling,

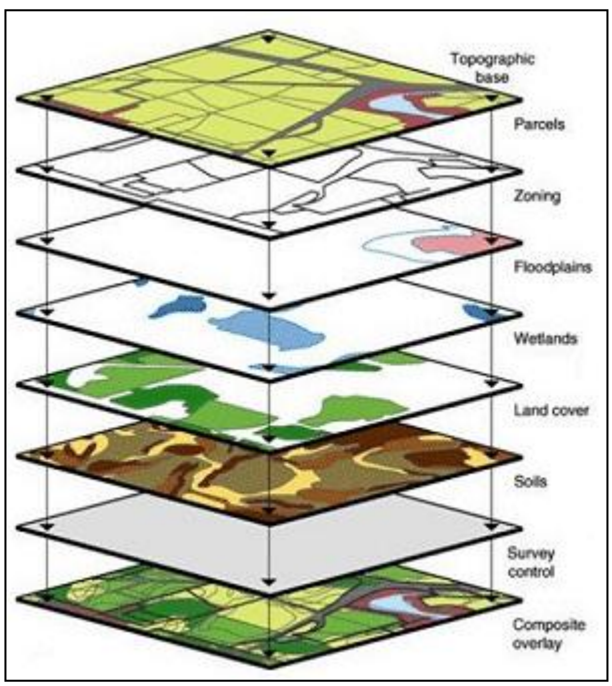

Figure 2: Example of GIS data layering procedures

analysis, storage, processing, and display. In evaluating changes in "on the ground" surface mine features, the use of geographic information systems has allowed us to reference all our data spatially to consistent projected and geographic coordinate systems. In order to facilitate the calculation of the area and number of abandoned mine features affected by remining, spatial georeferencing was performed on three National Aerial Photography Program (NAPP) aerial images from circa 1975/1976. These images show the historic (e.g. pre-SMCRA) status of all mined areas in Ohio, and allow the user to locate highwalls and highwall pits present prior to the enactment of SMCRA. These highwalls and pits are then digitized and saved in a polygon feature class. When digitizing, ODNR AMLIS (Abandoned Mine Land Inventory System) topography maps are used to confirm the locations of possible mine lands by comparing them with the pink and purple stippled areas representing

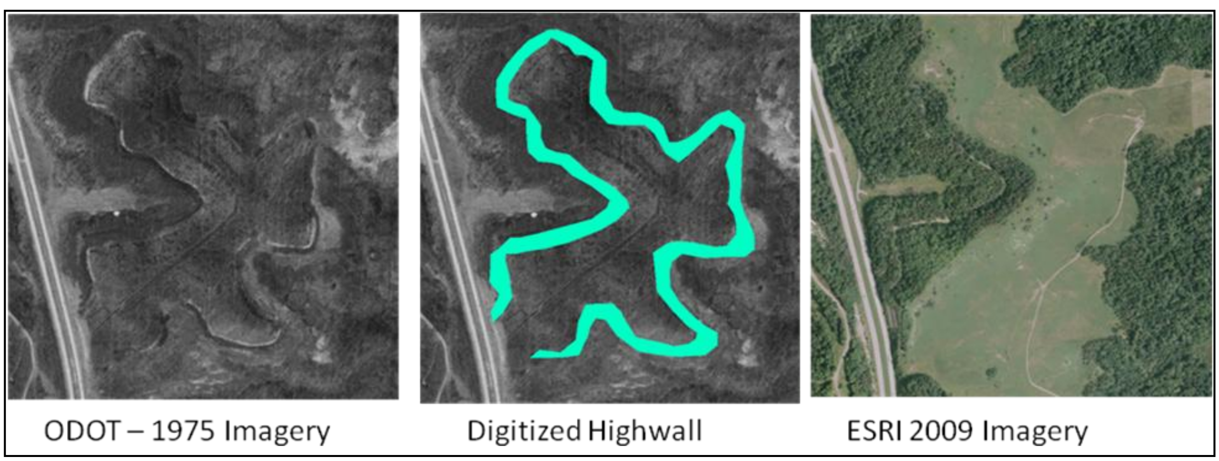

Figure 3: Highwall digitization process using GIS

to the edge of the highwall in order to achieve a consistent method for calculating affected mine area.

Once recorded, each feature is represented by a "tuple" or record within the database. Fields are then created to store attributes such as reclamation status, polygon area, and permit association. Once the feature database's relational structure has been modeled, the analysis phase can begin. By referencing the aerial imagery to 2009 (National Agriculture Imagery Program) aerial photo mosaics, we can compare the highwall features present in 1975 to the current conditions on the ground.

2. *Locating Mine Sites*

Each feature within the abandoned mine land database is given a classification based on reclamation progress. These classifications are as follows: 1 = unreclaimed, 2= partially reclaimed, and 3 = full reclamation. Complete accuracy is difficult to accomplish due to the fact that forest regrowth often occurs on abandoned mine lands, obscuring important features used to aid in classification.

Once reclamation status is established, spatial data detailing the extent of Ohio mine permits is obtained through the Division of Mineral Resources Management's GIMS database for use in the GIS (DMRM, 1981). These permits are used to establish the permit designation of each abandoned highwall feature present in 1975. If the permit designation for a fully reclaimed mine site is B, C, or D, then Modern Mine Law applied the reclamation standards to a previously abandoned (pre-1975) surface mine site, and remining has occurred.

Once the remining sites are isolated, I used basic GIS functions to calculate summary statistics of the remined area. Using a DMRM produced shapefile showing the extent of AML Program sites, I determined which areas have been remined since the implementation of limited reclamation techniques on pre-law sites using state funds. Sometimes sites that are overlayed by both remining features and AML Program features can reveal cooperative efforts between state and industry actors.

The process for identifying remining sites and abandoned mine lands is straightforward (see Figure 5 below), but it is important to recognize the limitations of this technique. First, the three year gap between the 1975 NAPP imagery, and the enactment of Ohio's B-Mine Law (1972) allows for the possibility of mines to have been remined in this period (ODNR, 1980). Other states whose reclamation standards were not rigorous prior to SMCRA might cause the GIS investigator to overlook existing highwalls and pits in this gap period. Second, measuring the affected area of abandoned mine lands raises questions as to how to define "affected area". Surely the places where sedimentation and acid mine drainage have effected streams and watersheds should count as an affected area. Still, measuring from the edge of the highwall to the top of the spoil pile allows for a consistent measure of this critical variable and prevents over or underestimation that could result from choosing the inner or outer embankment edge as the starting point for an affected area designation.

This GIS procedure has proved useful in previous research I have undertaken to document the extent of abandoned mine lands in the entire Ohio coal-bearing region. Also, this procedure could be used to inform beginner and intermediate GIS students as they learn to georectify raster data and digitize features within ArcMap.

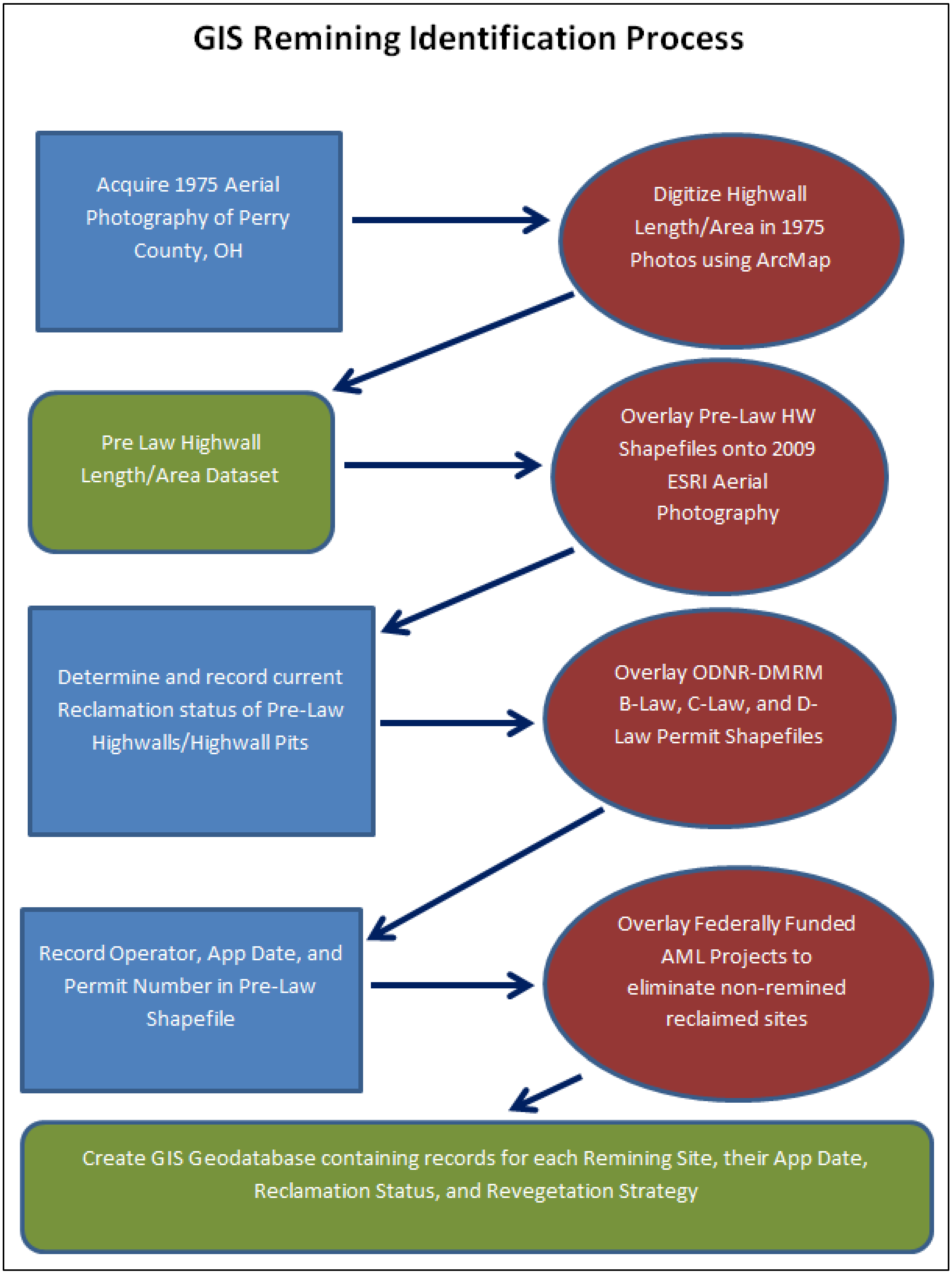

Figure 4: GIS Remining Identification Process

b. POLITICAL ECOLOGY

In studying with the OSU's Appalachian Ohio Forest Research Group (Department of Geography), I have gained a greater appreciation for the ways in which the practices of local people, industry, and the state serve to both create and destroy ecological systems and landscapes. For the political ecologist, documenting the details of acts which constitute a "social construction of nature" is as necessary as measuring environmental degradation (Robbins, 2004). To be sure, many acts of construction also constitute acts of degradation dependent on the changes in productivity and usefulness that are realized by the many actors connected with a site's history. Despite these challenges to measuring degradation, political ecology sets forth a framework within which one can assess the changing characteristics of a disturbed landscape. The following factors may be analyzed to determine the extent of a system's degradation.

- Loss of natural productivity
- Loss of biodiversity
- Loss of usefulness
- Creating or shifting risk ecologies (Robbins, 2004)

For this study, two of these factors have been selected as focuses for measuring environmental change on the three remining site case studies. First, the changing utility or usefulness of a site has been investigated through insights gained during interviews and permitting records requests (see below). Second, shifting vulnerabilities (e.g. risk ecology), as a result of the elimination of externalized risks placed on local populations, will be considered when evaluating these sites. Methodologically, this political ecology analysis poses some obstacles, specifically when attempting to quantify or measure changes in usefulness and vulnerability. The following research methods have allowed me to evaluate these changes qualitatively, contextualizing the feedback gained through interviews, records requests, outreach opportunities and field work. These sources of evidence give me the materials with which to establish the overall type of changes brought about through the remining process.

1. Records Requests

The Ohio Department of Natural Resources Division of Mineral Resource Management provides access to historic and active mine site permitting records upon request. These permits contain a wealth of information, including water quality monitoring data, descriptions of site conditions before and after remining, documentation of mining and revegetation strategies, and expected impacts on site ecology (DMRM, 1981). Throughout the thesis process, I have visited DMRM numerous times to survey their permits in an effort to select the most unique remining case studies for analysis. Permitting records queried include D-2254 (New Lexington), D-2255 (Jockey Hollow West), and D-0706 (Macksburg).

2. Field Work

Since August, 2010, I have completed 5 field visits to the remining case study sites, along with numerous other remining sites in the Ohio coal bearing region. These visits have often been accompanied by representatives of the mining companies responsible for the reclamation and revegetation of the site. For example, the President of Oxford Mining, and the Vice President of B&N Coal joined me during my visits. These site tours allowed me to photo document site conditions and explore not only the reclamation and revegetation efforts of industry in the region, but also the impacts of active mining operations in nearby areas and on-site.

3. *Interviews*

Because my work studying remining in southeastern, OH has put me in such close proximity with industry representatives, local individuals and groups, and regulatory/permitting officials, the specific perspectives of these actors were readily available to me through interviews. Their insights represent the key to understanding why revegetation is approached in specific ways, and how these approaches are being challenged going forward. I have conducted and participated in eight interviews while researching remining and land-use changes over the last year. These interviews were documented through detailed note-taking.

4. *Participant Observation*

Throughout my research experience, I have had the opportunity to present research findings to watershed groups, mineland partnerships, reclamation conferences, and industry events. While attending these events, I took the opportunity to record the perspectives of different participants in order to understand how institutional preferences and biases affect the development of a comprehensive remining policy in Ohio. I have spoken to the membership of the Duck Creek Watershed Group, Ohio Mineland Partnership, The Ohio Remining Task Force, and the National Association for

State Land Reclamationists. I use the perspectives of these groups in the results of the case studies to explain how institutions can misinterpret land-owner concerns regarding future land utility and shifting vulnerabilities due to changes in coal extraction process inherent in remining.

c. CASE STUDY SELECTION

For the purposes of this study, I have selected 3 case study sites within the Ohio coal-bearing region. These sites were selected to represent the range of land-ownership possibilities when mining a previously mined area. The first, as described in the Introduction, is located just on the outskirts of New Lexington, OH. Here, Oxford Mining Ltd. is responsible for the mining and reclamation of permit D-2254. Using historic aerial imagery retrieved from the Ohio Department of Transportation, I assessed the pre-law condition of these sites prior to remining (DMRM, 1981-2011).

The second remining site is named Jockey Hollow West near Cadiz, OH. This site was remined under permit D-2255 by Cravat Coal Company and later Oxford Mining Ltd. This site has been revegetated through reforestation. Because this site is owned by the Ohio Division of Wildlife, it is useful to evaluate the different factors at play when state entities choose for themselves a land-use designation. Alternative compaction techniques advanced by the Appalachian Regional Reforestation Initiative, a coalition of groups dedicated to restoring forests on coal mined lands in the Eastern United States, has led to the successful growth of Chestnut trees on this site (DMRM, 1981-2011).

The third site chosen rests in the Duck Creek Watershed near Macksburg, OH. Permit D-0706 represents a site which has been reclaimed to pasture land, and is under the ownership of a combination of local citizens of the watershed and industry. Using the historic imagery (circa 1975) this study was able to both quantify the number and extent of highwalls eliminated through remining.

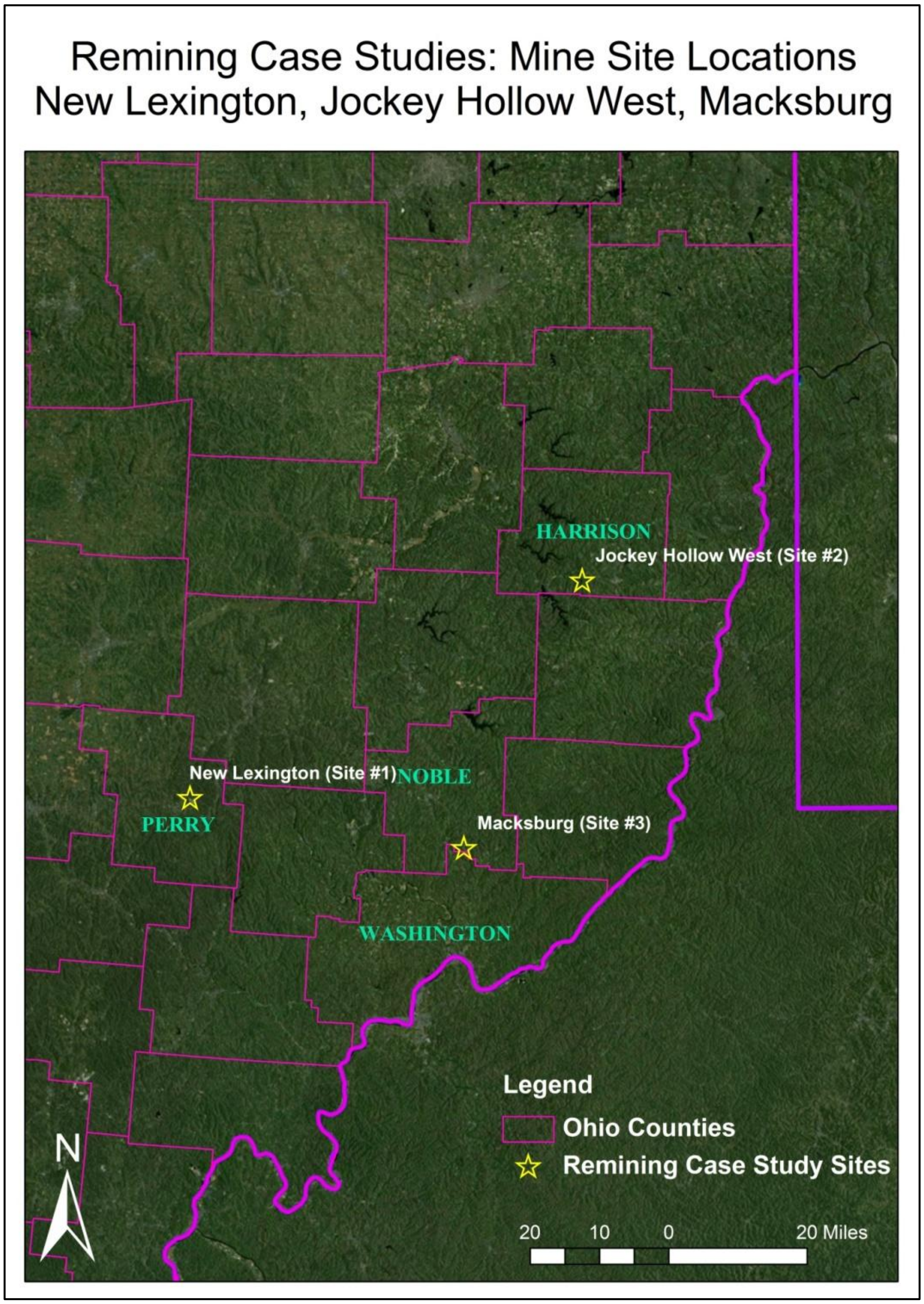

Figure 5: Remining Case Studies Map

VI. RESULTS

a. CASE STUDY #1: NEW LEXINGTON

1. GIS Application

Only 1 mile north-east of New Lexington, Ohio, Oxford Mining is involved in actively re-mining a complex of abandoned highwalls and pits. Stretching over 364 acres of land, this site contains valuable remaining coal reserves intended for sale to AEP's Conesville power plant. Using GIS, I have analyzed historic images retrieved through the Ohio Department of Transportation to quantify the extent of expected highwall and pit area reductions. Figure 7 shows the extent of the highwalls abandoned (1960 – 1975) within the permitted area. Table 2 describes the quantitative changes to land-cover in the area.

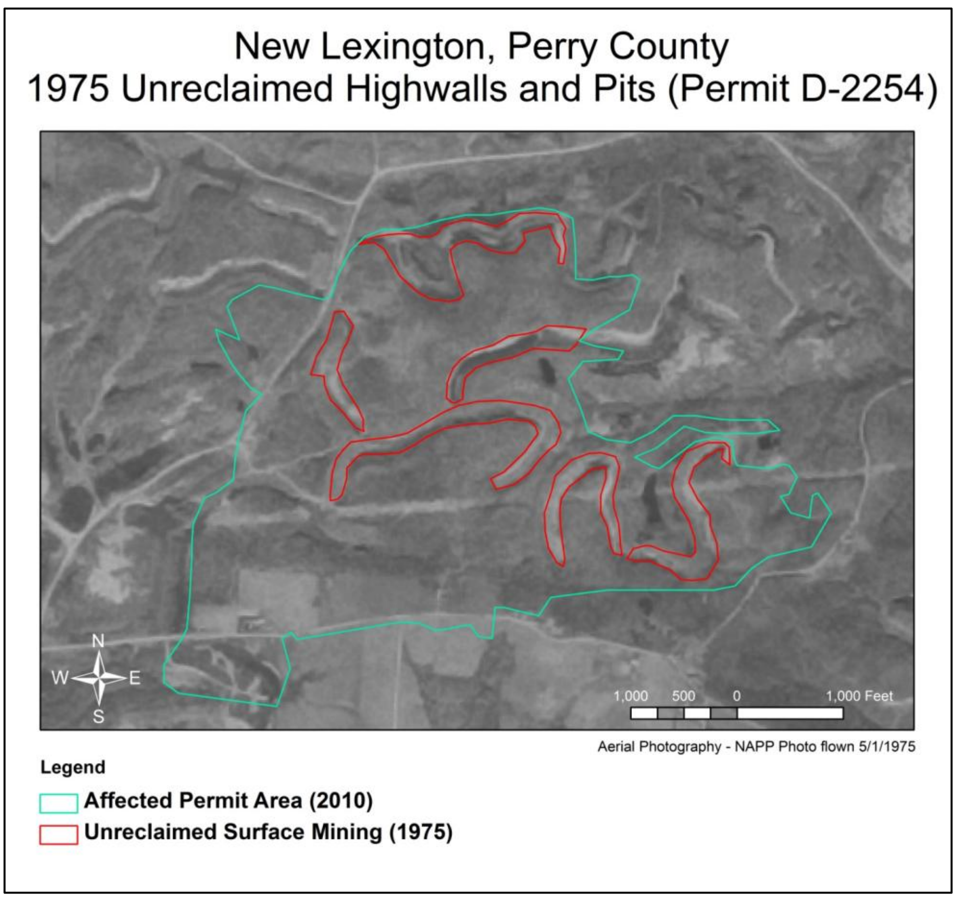

Figure 5: New Lexington Digitized Abandoned Highwalls and Pits

Table 2: Summary statistics for landscape changes and land-use changes

NEW LEXINGTON SITE	1975 (Pre-Law)	2010 (Post-Remining)
Total Affected Area (Acres)	51.30	364.18
Land-Use Change	97% Undeveloped, 3% grazing land	100% Undeveloped

2. Political Ecology Analysis

Prior to remining, the site's land-use has been described in DMRM permitting as "undeveloped". Viewing the aerial photography (1975), one can make out the contours of numerous coal refuse piles, devegetated barren areas, dangerous highwalls, and pit ponds. GIS analysis shows that over 97% of the pre-law area can be classified as undeveloped, with only 3% classified as grazing land. Permitting records indicate that following the completion of mining, the remaining grazing land would transition to an undeveloped state (11 acres). Oxford anticipates that the elimination of acidity sources and coal refuse piles will allow for increases in biodiversity, and usefulness in the area. Oxford maintains ownership over these properties and adjacent properties for future mining.

This introduces the first type of land-use transition, from undeveloped to undeveloped. In an interview with Wayne Light, President of Oxford Mining, in August, 2011 he commented on the impact of remining near New Lexington, saying, "Remining has brought a great benefit to the economy and environment. These pits and highwalls aren't going anywhere unless operators can be permitted to fully reclaim an area through remining (Light, 2011)." Despite apparent improvements, maintaining the land use classification as "undeveloped" ignores the drastic change that is been implemented on the landscape and infers the coding of explicit social goals into land-use designations. Clearly a drastic change is occurring on the land, and that change is ignored by the continuing use of the term "undeveloped" to describe its use designation. Being less than one mile from New Lexington and within walking distance of local schools, these highwalls have posed significant risks to local people and communities for more than 50 years representing not a lack of

Figure 6: An Ore Hauler waiting for a new load of overburden at Oxford D-2254 site

development, but the scars of development being externalized by mining operations onto local communities (Bridge, 2004). Furthermore, referring to a landscape as "undeveloped" influences an observer to think about the site as in a stage of development. Time will tell whether this site becomes a viable location for productive forces to take root, but the assumption of a state along the trajectory of development is not necessary in this context.

Today the site is being operated by nearly 60 miners working both night and day shifts, averaging 60-70 hours a week full time. Having toured this site with the President of Oxford Mining, I had the opportunity to speak with a miner, Ben McMaster, who was also a local resident of the area. A 28 year old part-time student at Columbus State, Ben works over 35 hours a week at the D-2254 mine site. Also being a local resident, I asked him whether he felt that remining was restoring the usefulness of the landscape. He responded saying that, “It’s fantastic if these abandoned sites can be cleaned-up a bit, but for me the real benefit of these operations come from the jobs they create (McMaster, 2011).” He went on to tell me that active mining operations bring in over $2.7 million of annual income to New Lexington. Remining for mine workers represents not merely a change in land-usefulness; but more importantly, a reduction in economic vulnerability for the 60+ workers who obtain these positions.

3. Future Operations

Surveying this active operation, I began to understand immediately how over 200,000 acres of Appalachian, OH had been mined through so thoroughly. While visiting, a blasting operation was taking place, lifting countless tons of overburden from above the coal seam. As an ecologist and geographer, I immediately realized that characterizations of South-eastern Ohio as a post-extractive landscape are in some ways mistaken. Extraction continues to take place in areas where the remaining coal reserves hold value for operators. With remining gaining momentum in the region I expect that future operations will increase, and operators will expand their presence to keep pace with new opportunities. Speaking with Wayne and his foreman, plans are in place to continue mining towards the Northwest, and through existing highwalls and pits.

To the east of the permit lies a remined site riddled with damage attributable to underground mining operations. Named after a landowner in the area, the "Rambo" site is potentially unique in that it represents collaboration between ODNR-DMRM and Oxford Mining to implement an AML Enhancement incentive for remining. This choice of incentive exempts the operator from water quality monitoring, inspections, and the traditional permitting process. The AML Enhancement Rule is intended to allow the operator to mine in a risk filled environment (in this case, McLuney Creek in the Moxahela Watershed) with the intention of reclaiming highwalls and pits that would not normally be approached through the traditional AML program. Because a remining operation can clean up the water quality in the area profitably, the state incurs no cost for the project and can instead focus the majority of its nearly $20 million annual budget on other sites SE Ohio's watersheds.

b. CASE STUDY #2: JOCKEY HOLLOW WEST

1. GIS Application

The Jockey Hollow West remining site is located 6 miles southwest of the town of Cadiz in Harrison County. Using GIS, this study has quantified the spatial extent of remining associated with the reforestation of these abandoned mine lands. The figure below shows the state of the mine lands circa 1976, and outlines the total affected areas and unreclaimed highwalls present at the site. Today, over 170 acres of land have been affected through modern day mining operations, with over 75 acres of steep highwall eliminated in the process.

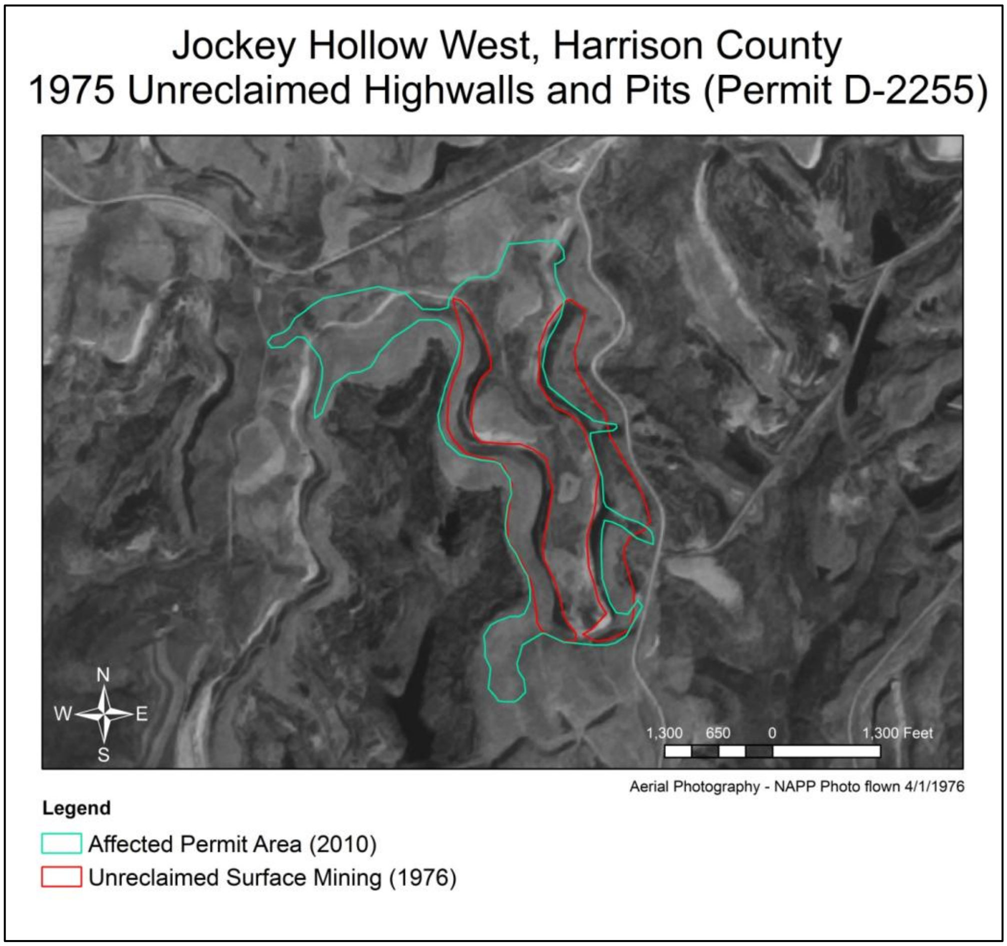

Figure 7: Map detailing the extent of Unreclaimed Surface Mining of the Jockey Hollow Mine Site

Table 3: Summary statistics for landscape change and land-use change on the Jockey Hollow West Mine Site

JOCKEY HOLLOW WEST	1975 (Pre-Law)	2010 (Post-Remining)
Total Affected Area (Acres)	76.30 (2 features)	171.57
Land-Use Change	100% Undeveloped	22.7% Grassland, 77.3% Recreational

2. Political Ecology Analysis

The mineral rights to the land were sold to Cravat Coal Company by the State of Ohio in the hope that Cravat would be able to restore the land to pre-mining conditions to the best of their ability. Because the state (Division of Wildlife) maintained ownership of the land, it was up to them to choose the post-mining land use for the area. In contrast to land owned by local residents and mining operators, the Division of Forestry chose to reforest the land, encouraging Cravat Coal to plant the rare American Chestnut tree on the reclaimed mine site (Moore, 2011). Traditionally, coal operators have not been interested in planting hardwood trees on reclaimed mine sites. They often cite poor hardwood survival rates on reclaimed soils and a lack of public preference for reforestation instead of grazing and pasture land (Moore, 2011).

Fortunately, the Appalachian Regional Reforestation Initiative (a coalition of citizens, industry, and state representatives committed to the restoration of forests on mine lands) began developing the Forestry Reclamation Approach in late 2005. (Burger, 2005) The FRA approach was developed as a response to problems ARRI saw with the implementation of SMCRA with regards to reclamation and revegetation on surface mine sites. ARRI published a series of Forest Reclamation Advisories to guide the reforestation process. In the first advisory, ARRI addressed the negatives associated with traditional reclamation techniques:

> Following SMCRA's implementation, regulators focused on stability of landforms created by mining at the expense of restoring forest land capability. This approach was caused by a desire to solve the problems such as severe erosion, sedimentation, landslides, and mass instability caused by

> pre-SMCRA surface mining. As a result, excessive soil compaction was common on surface mines, and aggressive ground covers were generally planted. (Burger, 2005)

To explain the Forestry Reclamation Approach, ARRI details five steps necessary for the reforestation of mined lands.

> 1. Create a suitable rooting medium for good tree growth that is no less than 4 feet deep and comprised of topsoil, weathered sandstone and/or the best available material.
>
> 2. Loosely grade the topsoil or topsoil substitute established in step one to create a noncompacted growth medium.
>
> 3. Use ground covers that are compatible with growing trees.
>
> 4. Plant two types of trees--early successional species for wildlife and soil stability, and commercially valuable crop trees.
>
> 5. Use proper tree planting techniques. (Burger, 2005)

Cravat and the Division of Mineral Resource Management cooperated to advance the Forestry Reclamation Approach. Using this technique, the operators planted over 4,840 Chestnut trees on 100 acres of reclaimed land at the site, along with over 75,000 other trees including chokeberry, silky dogwood, American plum, American crabapple, sycamores, and red, white, and shumard oaks. The planting of a wide variety of trees in an effort to promote bio-diversity is entirely an entirely new approach taken by operators and state landholders. This approach seeks to minimize the homogeneity present in many tree plantation type sites that have been planted on reclaimed mine lands in the past and increase the usefulness of sites to wildlife and recreationalists.

Cravat Coal was sold to Oxford Mining shortly after the planting of the Chestnut trees, which allowed Oxford to also contribute the reforestation of the remined site. The reclamation work completed on the Jockey Hollow Mine site has received numerous awards including recognition from the Department of the Interior's Office of Surface Mining and the Appalachian Regional Reforestation Initiative (DMRM, 1981-2011). Today, the site has become a part of the 3,500 acre Jockey Hollow Wildlife Area, where public hunting and trapping are identified as the primary recreational uses (DMRM, 1981-2011).

Figure 8: Aerial photo of Jockey Hollow West Remining site showing reforestation

c. CASE STUDY #3: MACKSBURG

Located just to the east of the West Fork of Duck Creek, the D-0706 remining site represents a site that has been reclaimed to grassland using the traditional methods prescribed in the SMCRA and Ohio Mine Law guidelines. Permit D-0706 was mined by B&N Coal beginning in 1991. Starting in 2000, Permit D-0706 was remined under a modified effluent permit made possible by amendments to the NPDES criteria explicated in the Clean Water Act (USEPA, 2001). D-0706 was not originally an explicit remining operation; however, over time the presence of dispersed acidity near streams caused B&N to seek reductions in the water quality standards. Necessitating seven additional adjacent area permits, the D-0706 was finally completed in 2005. Again, I use GIS mapping techniques to quantify the area of highwalls and pits eliminated through this remining operation.

1. GIS Application

The figure below shows the extent of modern mining and historic mining overlayed onto 1975 aerial photography. 256.37 acres were mined at the Macksburg Site, with 33.40 acres being reclaimed through remining. To be sure, 13% of total area remined would not be considered ideal under today's remining standards, however most of the areas that were remined only received reduced water quality standards on adjacent area permits where the proportions of remining to virgin mining are far more encouraging.

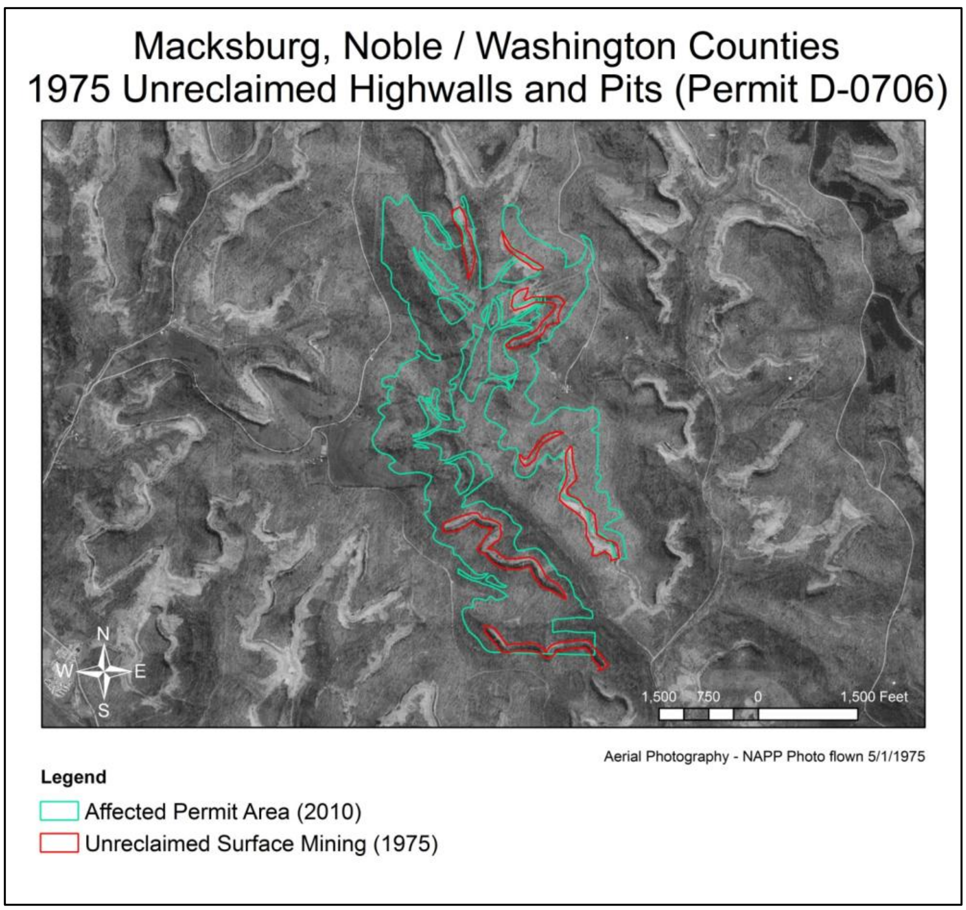

Figure 9: Spatial extent of remining operations and abandoned highwalls on permit D-0706

Table 4: Summary statistics for landscape change and land-use change attributed to remining

MACKSBURG CASE STUDY	1975 (Pre-Law)	2010 (Post-Remining)
Total Affected Area (Acres)	33.40 (7 features)	256.37
Land-Use Change	100% Undeveloped	100% Grazing-land

2. Political Ecology Analysis

The initial application called for 7 acres of remining and 17.1 acres of virgin mining. The land on the D-0706 permit had historically been used as grazing land, but prior to remining, the land had reverted to the “undeveloped” state mentioned in both the New Lexington and Jockey Hollow West case studies (DMRM, 1981-2011). The reclaimed land is characterized by the planting of “forager” fescue (a leguminous plant) by the operator to stimulate wildlife and biodiversity. According to the permit records, B&N intended to change the recorded land-use of the permit from “undeveloped” to grazing land, citing the preferences of local landowners and

Figure 10: Institutional outreach opportunity with local watershed group

recreationalists (DMRM, 1981-2011).

Unlike the New Lexington site, the reclaimed areas of permit D-0706 are being re-engineered to provide some nominal benefit to local people in the form of grazing land. In my conversations with member of the Duck Creek Watershed Group, most landowners voiced support for B&N's work in the area. While dismayed at the periodic choking of streams with sedimentation, most landowners expressed excitement at the prospect of returning their land to a potential productive use for them and their families. One representative of the group, Jack Butler, spoke to me, saying that previous highwalls on his land provided little value to him in the past. (Butler, 2011) He lamented that gardening on mine spoils is made more difficult due to high acidity and metal concentrations. When I asked how he felt about reforesting using the FRA approach, he claimed that his land had never been forested as far back as he could remember. Even before the initial impact of mining which left the site unreclaimed, the Butlers had utilized the landscape for different purposes (grazing-land) than forestry or recreational use (Butler, 2011).

Roger Osborne, Vice-President of B&N Coal Inc., is tremendously proud of the reclamation work B&N has implemented in the Duck Creek Watershed. Mr. Osborne often refers to himself as an environmentalist, citing his extensive work remining in some of the most severely polluted areas of the Duck Creek Watershed. (Osborne, 2011) Duck Creek was identified in the 1974 Land Reborn Report, commissioned by the Ohio Department of Natural Resources, as the #1 priority watershed in the state of Ohio for recommended reclamation and remediation effort to control acid mine drainage. (Skelly and Loy, 1974) The report showed over 38,000 lbs/day of acid being discharged into the Ohio River from the West and East Forks of Duck Creek. (Skelly and Loy, 1974) State AML funds have partially reclaimed many portions of the watershed through the regrading of mine spoil and planting regimes. Further, over 500 acres of abandoned highwalls have been reclaimed through the remining process (Mauger, 2011). Analysis of water quality in the area pre- and post-remining was conducted by researchers in the OSU Department of Civil Engineering. This work determined that pollution concentrations for water quality permitting test sites downstream of remining operations show improvements in pH, acidity, iron, manganese, and sulfates (Mauger, 2011). Much of this improvement can be attributed to the sealing of remaining auger holes from pre-law mining, but the restoration of the previous hydrologic regime has also been credited with reducing sedimentation risks in the area. B&N has initiated more remining operations than any operator in the state, totaling more the 15 since the late 1980's (Mauger, 2011).

The table above details the specific changes on each case-study along with their respective ownership type.

	New Lexington (Case Study #1)	**Jockey Hollow West (Case Study #2)**	**Macksburg (Case Study #3)**
Landholders	Oxford Mining Ltd. (Industry)	Division of Wildlife (State)	4 Local Residents, B&N Coal (Industry)
Revegetation regime	Grassland Seeding Mixture	Reforestation (ARRI FRA Approach)	Grassland Seeding Mixture
Pre-Remining Land-Use	96.3% "Undeveloped" 3.0% Grazingland 0.7% Pond	100% Undeveloped	100% Undeveloped
Post-Remining Land-Use	100% "Undeveloped"	22.7% Grassland 77.3% Recreation	100% Grazingland

IV. DISCUSSION

While developing the GIS technique for locating remining sites on the landscape, I was surprised to find that some of the features in the GIS shapefies provide to me by the state were inaccurate. This means that researchers must, in some selected cases, redo the work to determine the precise extent of the phenomena in question. Representatives of DMRM have told me that the labor of prisoners has been enlisted to repeatedly digitize AML Program sites, and the results are at times shockingly inaccurate.

Another surprising development involved the ubiquity of a preference for pasture/grazing land among local landholders. Being consistent across the majority of operators surveyed for this study, a perceived preference by locals for pasture/grazing land as a post-mining land use supports industry opposition to widespread reforestation as a method for reclaiming most coal mining sites. Increased cost and a lack of expertise are cited as barriers to making this land-use the default for reclaiming mine lands. Economic analysis of the benefits of forest growth on private mine lands appear to contradict this narrative, and the ARRI Forest Advisories further diminish support for the claim that lack of expertise should stand in the way of reforestation efforts (Aggett, 2003, Brady, 2002, Burger, 2005, Caldwell, 1990). Oxford has said that they will continue to use reforestation as a technique for reclamation in Ohio. They predict that because the process is being formalized and standardized, reforestation will become cheaper over time, possibly even less expensive than hard compaction regrading and revegetation to dense grasslands which choke out trees attempting to survive on these dense soils.

The state and its agencies involved in reclamation and land ownership have been shown to promote remining when it serves its purposes of restoring a previously degraded area. The United State Environmental Protection Agency stated the following in their proposed guidelines to a remining subcategory in reference to changes in land-use brought on through remining:

> These changes are likely to increase the value of land for post-remining uses. Among the post-reclamation uses reported for past mining areas are wildlife habitat, hunting preserves, pasture/hayland, public park and open space for community use (Smith and Bridger, 1998). An increase in the number and diversity of wildlife species, improved aesthetic quality, and availability of recreation amenities (e.g., state parks) will enhance recreational activities such as hunting, wildlife viewing, biking, hiking, and photography. (Streller, 2000)

In this excerpt, USEPA prioritizes recreation as a post-mining land-use, however; as this study has shown, landowners have differing visions for post-remining land-use. Some residents prefer grazingland, while state agencies have been shown to prefer recreation in this case study. Oxford mining maintained the undeveloped designation for the majority of their reclaimed abandoned mine sites. Through numerous interviews, extensive field work, and countless trips to Fountain Square (ODNR Headquarters) to study permitting data, a surprising land-use preference narrative revealed itself which contested my conventional understandings of land-use preference in Appalachian Ohio.

Most operators claim that a transition to pasture land or crop land has been preferred by local landowners, and the evidence collected through permitting records, interviews, field work and outreach suggests this is true. While it can be debated whether or not operators are claiming this preference by landholders in an

Figure 11: Grazing land on reclaimed remining permit D-1086

Figure 12: Aluminum and iron laden pit pond near proposed New Lexington Rambo site

attempt to decrease perceived costs to themselves is an issue which could be debated in future research. Regardless of industry motive, the fact remains that most landholders in Ohio coal bearing regions would prefer to realize the immediate benefits of grazing land as opposed to a reforestation approach which fails to provide immediate value to local people and increases their economic risks.

Future research should investigate the developing impact of remining on the Ohio landscape as it continues to gain momentum over time. As landscapes are constructed by humans other use values are lost. The loss of some wetland habitats created in abandoned mine site pit ponds and hollows represents a loss of nature which must be considered when determining the long-term positive or negative impact of remining in the region.

With respect to the GIS portion of this thesis, future work should use the process I have developed for locating abandoned highwalls that have been remined since the implementation of modern mining regulations to evaluate the changing character of vegetation on these mines sites using remote sensing and NDVI vegetation indices to assess the current health of a site quantitatively.

VII. CONCLUSION

Research into mine reclamation is a case study in itself for the codification of social goals onto landscapes by their landowners. Mine permitting documentation requires that operators detail planned land-use status following reclamation, and if that status is expected to change prior to and after the conclusion of mining an application must be submitted to request this change. (DMRM, 1981-2011) Because of this, human constructed land-use histories are surprisingly rich in the extensive supply of mine permitting data. In the case of remining, reclamation represents an opportunity for landholders to ascribe their own social goals onto a landscape that had served little purpose to them up to this point.

The codification of social goals to landscapes is in no way a new phenomenon. In "The Trouble with Wilderness", William Cronon describes the process through which landscapes of "nature" and "wilderness" are byproducts of cultural yearnings brought on by the quickening pace of industrialization in the mid to late 19th century. (Cronon, 1995) In her paper "Reclamation and Reconciliation: Land-Use History, Ecosystem Services, and the Providence River", Laura Martin describes the transformation by the community of the industrial district in downtown Providence, RI, to a vibrant environemental art scene known as *WaterFire*, saying it represented the "wish of citizens to return to an earlier, richer relationship with nature, 'setting right something we messed up (Martin, 2009).'"

When landscape capacities and uses change due to the prescriptions of human social goals onto the land, improvements in land usefulness and decreases in risk are traditionally sought. In the three case studies, private and public institutions and local populations sought to decrease personal vulnerabilities while increasing land utility by ascribing their own objectives onto the landscape.

As I surveyed sites for selection, my primary objective was to have industry, state, and local landholders represented in the case studies. Each remining case study demonstrates a different type of land-use transition chosen by the site ownership.

In the new Lexington Case Study, operator Oxford Mining elected to increase the total amount of undeveloped land post-remining. The sustained "undeveloped" state of the land reflects an unwillingness to incur the associated costs of reforestation or cropland. The Appalachian Regional Reforestation Initiative has published numerous advisories debunking the popular conception among industry that reforestation represents a greater cost to operators (Aggett, 2003, Brady, 2002, Burger, 2005, Caldwell, 1990). Still, the process has been slow to gain acceptance among operators in the coal bearing regions of Appalachia when mining private or industry owned lands. This reluctance demonstrates the kind of institutional inertia that industry has gained towards reclaiming mine sites to grassland, and is also intended to decrease the economic vulnerability of industry actors in the remining process.

The next case study, Jockey Hollow West, shows that when land is owned by a state entity and mined by a coal operator, the chances are better that an alternative revegetation regime could be implemented. According to some representatives of Oxford, the reforestation effort on the Jockey Hollow Mine site represented cost in excess of traditional reclamation protocols, but because the Division of Wildlife was interested in reforesting the land, Oxford Mining implemented the FRA approach to obtain the profits from mining the excess coal.

Officials cite the cost of the increased labor as influencing the total cost of the reclamation effort (tree planting stocks were provided to Cravat Coal and Oxford Mining through state funds). In an interview, Marcie Moore, permit coordinator for Oxford, communicated to me that Oxford believes that because the land was and is owned by the Division of Wildlife, the land was more likely to be reforested than if the land had been owned by a private landowner (Moore, 2011). Within the Ohio coal mining industry, the conventional wisdom is that private, local landowners prefer grazing land and pasture land as a post-mining land-use. Reforestation is seen by industry as limiting the possible future utility of the land to the landowner.

When the landowner is the state, however, the goals of the specific institution of ownership are ascribed to this re-engineered landscape. The Division of Wildlife wanted to create the Jockey Hollow Wildlife Area by reclaiming the land using the Forestry Reclamation Approach. This objective allowed the state to eliminate a local environmental risk (abandoned highwalls and pits) and establish a recreational area (increase the utility of the land to the public) at only the cost of the trees to be planted.

The final case study demonstrates a shift in land-use from “undeveloped” to grazing land. In speaking with the operator, B&N Coal, and through an interview with a local resident, I determined that the presence of landowners on the site who desired an improvement in post-mining land use from undeveloped to grazing land influenced the process in favor of the establishment of grazing land. The goals of local people are to realize some economic or use value from their land which had been of diminished use to them in the past.

When pressed on whether local landowners would prefer reforestation to the conventional regrading techniques employed by mine operators, an overwhelming majority of the members of the Duck Creek Watershed Group asserted a preference instead for land which could be used for productive purposes. As I participated in field work and interviews during a retreat for OSU Department of Geography's Appalachian Ohio Forest Research Group (AOFRG) in August, 2011, I saw the value of timber to local people in a different perspective. Because of significant reforestation in southeastern Ohio, timber prices are depressed, leading land-owners to seek alternative uses on the land. Most parcels are too small to generate interest from timber companies even if they had been reforested.

In his book, *Political Ecology*, Paul Robbins asks, "Is land more useful when it is providing the highest return or providing the greatest collective benefit to a community?" (Robbins, 2004) This question gets to the heart of whether reforestation or grassland revegetation should exist as a preferred technique for reclamation of remined lands, and if so, to whom does it provide the greatest gain in usefulness or reduction in vulnerabilities? By constructing a GIS model to locate and characterize the changes to pre-law abandoned highwalls caused by remining, and by using numerous social science research techniques such as field work, interviews, records searches, and participant observaton; this research has uncovered a surprising pattern in the land-use preferences for this emerging type of reclaimed mine site. Local landowners and communities have demonstrated a preference for increased utility and will tend to implement the land-use category most suited to decreasing their long-term economic risks. This means that reforestation is not likely to be their technique of choice for reclaiming remining sites. Coal operators like Oxford Mining will implement the land-use that is determined to bring the most utility and least risk to themselves and their institutions (public or private). When the state has the opportunity to restore a landscape at little-to-no cost while realizing the benefit of new recreational spaces for local people, it will jump at the opportunity to restore the landscape to reflect its own land-use goals.

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